CLAIMS

What is claimed is:

1. A method for forming a photonic-crystal filament, the method comprising the steps of:

a) mixing a slurry comprising particles of substantially uniform size and a precursor material for a desired metal;

b) urging the slurry through an orifice to force the particles and precursor material into a combination having a desired crystallographic configuration;

c) drying the combination emerging from the orifice; and

d) sintering the precursor material, whereby a photonic-crystal filament is formed.

2. A photonic-crystal filament made by the method of claim 1.

3. The method of claim 1, further comprising the step of:

e) compressing the slurry.

4. The method of claim 1, further comprising the step of:

f) heating the dried combination to remove the particles.

5. The method of claim 4, wherein the heating step f) and the sintering step d) are performed simultaneously.

6. The method of claim 1, wherein the particles comprise an inert material.

7. The method of claim 1, wherein the precursor material comprises a metal oxide.

8. The method of claim 1, further comprising the step of:

g) reducing the precursor material to metallic form.

9. The method of claim 8, wherein step g) of reducing the precursor material comprises heating the precursor material in a reducing environment.

10. The method of claim 9, wherein the reducing environment comprises a gas selected from the list consisting of hydrogen, forming gas, a carbide gas, acetylene, and mixtures thereof.

11. The method of claim 1, further comprising the step of:

h) providing a core filament and feeding the core filament through the orifice while urging the slurry through the orifice to force the particles and precursor material into a combination surrounding the core filament.

12. The method of claim 11, further comprising the step of:

i) passing an electric current through the core filament, whereby the core filament is heated.

13. The method of claim 12, wherein the electric current heats the precursor material to an effective temperature for sintering the precursor material.

14. The method of claim 11, further comprising the step of:

j) removing the core filament after the precursor material is sintered.

15. The method of claim 1, further comprising the step of:

k) compressing the precursor material within a sheath.

16. The method of claim 15, wherein the sheath comprises a metal.

17. The method of claim 16, wherein the metal of the sheath comprises copper.

18. The method of claim 15, wherein step k) of compressing the precursor material is performed by drawing the sheath through at least one die.

19. The method of claim 18, wherein step k) of compressing the precursor material is performed by drawing the sheath through a series of two or more successively smaller dies.

20. The method of claim 15, wherein the sheath comprises a gas-permeable material.

21. The method of claim 15, further comprising the step of:
l) removing the sheath after the precursor material is sintered.

22. The method of claim 15, further comprising the step of:
m) providing a core filament and feeding the core filament through the orifice while urging the slurry through the orifice to force the particles and precursor material into a combination surrounding the core filament and while compressing the precursor material within the sheath.

23. The method of claim 22, further comprising the step of:
n) removing the sheath after the precursor material is sintered.

24. The method of claim 22, further comprising the step of:
o) removing both the sheath and the core filament after the precursor material is sintered.

25. A photonic-crystal filament made by the method of claim 15.

26. The method of claim 1, wherein the desired metal is a refractory metal.

27. The method of claim 27, wherein the refractory metal is selected from the list consisting of tungsten, platinum, tantalum, molybdenum, and alloys thereof.

28. The method of claim 1, wherein the desired metal is tungsten or an alloy thereof.

29. The method of claim 1, wherein the precursor material comprises an oxide of tungsten.

30. The method of claim 1, wherein the precursor material comprises peroxopolytungstic acid.

31. The method of claim 1 wherein the particles comprise substantially spherical particles.

32. The method of claim 1 wherein the particles comprise non-spherical particles.

33. The method of claim 1 wherein the particles comprise polymer particles.

34. The method of claim 1 wherein the particles comprise polymer nanospheres.

35. The method of claim 34, wherein the polymer particles comprise a material selected from the list consisting of polystyrene, polyethylene, polymethylmethacrylate (PMMA), latex, and combinations thereof.

36. The method of claim 1, wherein the photonic-crystal filament has a desired photonic band-gap, and the substantially uniform size of the particles is adapted to provide the desired photonic band-gap.

37. The method of claim 37, wherein the desired photonic band-gap has a lower wavelength edge and the substantially uniform size of the particles is chosen to be about one-quarter the value of the lower wavelength edge of the desired photonic band-gap.

38. The method of claim 37, wherein the desired photonic band-gap corresponds to a wavelength between about 400 nanometers and about 7000 nanometers.

39. The method of claim 37, wherein the desired photonic band-gap corresponds to a wavelength between about 1200 nanometers and about 1800 nanometers.

40. The method of claim 1, wherein the photonic-crystal filament has a longitudinal axis and a selected crystallographic axis of the desired crystallographic configuration is aligned parallel to the longitudinal axis of the photonic-crystal filament.

41. A lamp filament made by the method of claim 1.

42. An incandescent lamp comprising a photonic-crystal filament made by the method of claim 1.

43. A light source comprising the incandescent lamp of claim 43.

44. A method of cladding a metal filament, the method comprising the steps of:

a) providing a metal filament;

b) mixing a slurry comprising particles of substantially uniform size and a precursor material for a desired metal;

c) urging the metal filament and the slurry through an orifice to force the particles and precursor material into a combination having a desired crystal configuration surrounding the metal filament;

d) drying the combination emerging from the orifice;

e) sintering the precursor material; and

f) compressing the precursor material within a sheath, while drawing the filament through a series of two or more successively smaller dies, whereby the filament is clad with a photonic crystal.

45. The clad filament formed by the cladding method of claim 45.

46. The method of claim 45, further comprising the step of:

g) compressing the slurry.

47. The method of claim 45, further comprising the step of:

h) heating the dried combination to remove the particles.

48. The method of claim 48, wherein the heating step h) and the sintering step e) are performed simultaneously.

49. The method of claim 45, wherein the particles comprise an inert material.

50. The method of claim 45, wherein the precursor material comprises a metal oxide.

51. A photonic crystal for covering a filament core, the photonic crystal comprising:

a first refractory metal substantially filling interstitial spaces between a set of substantially spherical voids disposed in a predetermined crystallographic lattice,

the set of spherical voids being disposed surrounding the filament core.

52. The photonic crystal of claim 52, wherein the filament core comprises a second refractory metal.

53. The photonic crystal of claim 53, wherein the first and second refractory metals comprise different metals.

54. The photonic crystal of claim 53, wherein the first and second refractory metals comprise the same metal.

55. The photonic crystal of claim 53, wherein the first and second refractory metals both comprise tungsten or an alloy thereof.

56. The photonic crystal of claim 52, further comprising a filling material disposed within the spherical voids, the filling material differing in refractive index from the first refractory metal.

57. The photonic crystal of claim 57, wherein the filling material substantially fills the spherical voids.

58. The photonic crystal of claim 52, wherein the filament core has a longitudinal axis and a selected crystallographic axis of the predetermined crystallographic lattice is aligned parallel to the longitudinal axis of the filament core.

59. The photonic crystal of claim 52, wherein the first refractory metal comprises tungsten or an alloy thereof.

60. A method of using a photonic crystal to reduce emission of selected wavelengths of radiation from a filament, the method comprising the steps of:

a) providing a core filament and an electrical input connected to the core filament; and

b) cladding the core filament with a photonic crystal material which is operable to reduce emission of selected wavelengths of radiation during the resistance heating of the filament when electrical energy is conducted to the input and to the core filament.

61. The method of claim 61, wherein the core filament has a longitudinal axis and the photonic crystal material has crystallographic axes, the method further comprising the step of aligning a selected one of the crystallographic axes of the photonic crystal material parallel to the longitudinal axis of the core filament.

62. A method for filtering light from a light source having a longitudinal axis, comprising the steps of:

a) providing a photonic crystal having a predetermined crystallographic axis and a photonic band-gap adapted to block selected wavelengths of light; and

b) surrounding the light source with the photonic crystal while aligning the predetermined crystallographic axis parallel to the longitudinal axis of the light source.

63. A filament comprising, in combination:

a) elongated filamentary means for emitting radiation in a range of wavelengths in response to resistance heating; and

b) means for filtering, surrounding the filamentary means for emitting radiation, the filtering means comprising a photonic crystal, the photonic crystal being disposed surrounding the filamentary means for emitting radiation, and the photonic crystal having a band-gap adapted to reduce the emission of selected wavelengths at least partially within the range of wavelengths.

64. An electrical device comprising:

a) a support,

b) a transparent envelope secured to the support and forming an enclosure therewith,

c) a filament having a metal core portion, and

d) an input for electrical energy secured to the support and electrically coupled to the filament, the metal core portion of the filament being coated with a photonic crystal material which is effective in reducing emission of selected wavelengths of radiation during the resistance heating of the filament when electrical energy is conducted to the input and to the metal core portion of the filament.

65. The electrical device of claim 65, wherein the selected wavelengths of radiation are selected infrared wavelengths and the photonic crystal material has a photonic band-gap corresponding to the selected infrared wavelengths.

66. The electrical device of claim 65, wherein the metal core portion of the filament has a longitudinal axis, the photonic crystal material has crystallographic axes, and a selected one of the crystallographic axes of the photonic crystal material is aligned substantially parallel to the longitudinal axis of the metal core portion of the filament.